Other design variations are needed for 100% turf parking areas. Larger radii should be planned for curves. The transition between natural turf and asphalt must be reinforced and feathered to withstand simultaneous energy sources (deceleration, turning, and change in elevation), which could result in separation of the edges.

Conclusions

Despite everyday successes of vehicular turf, and theoretical background, research is still needed to bring this concept to standard design specification. However, some generalizations are supported from experience. Light (two to three usages per parking space per week) parking is supported by turfgrasses in Florida, especially bahiagrass, on sand soil, but areas more heavily trafficked often need reinforcement. Grasses such as zoysiagrass which tolerate high mechanical impedance perform well in, or on top of, gravel and rock. Adequate irrigation must be available for turf parking. Tree shade is very detrimental to traffic tolerance, and it should be remembered that bahiagrass and bermudagrass are the least shade tolerant turf species in Florida.

Despite potential problems which occur from parking on the grass, the practice is widely successful. It is ironic that the immediate rationale for high impact turf is very often economic savings, not environmental. Vehicular turf distributes natural air conditioning to places where there are people, improves percolation to aquifers, and is enjoyed where it is used appropriately. If environmental benefits were more often considered first, designers might allocate the same resources for vehicular turf as for asphalt. Increased interest in alternatives could result in greater use of paver complexes, calcined clay, and other (as yet unperfected) materials, to make 100% turf a reality for public facilities throughout Florida. Because of their versatility, turf lots could provide overflow parking for shopping centers and other retail establishments. Compared with the asphalt alternative, many patrons would welcome the sight of a sea of grass.

Literature Cited

1. Adams, W. A. and R. J. Gibbs. 1989. The use of polypropylene fibers (VHAF) for the stabilisation of natural turf on sports fields. p. 237-239 In: H. Takatoh (ed.). Proc. Sixth Int. Turfgrass Res. Conf., Tokyo, Japan. 31 July-5 August, 1989. Japanese Soc. Turfgrass Sci. and Int. Turfgrass Soc., Tokyo, Japan.
2. Beard, J. B. 1973. Turfgrass: Science and culture. Prentice-Hall, Englewood Cliffs, NJ.
3. Bingaman, D. E. and H. Kohnke. 1970. Evaluating sands for athletic turf. Agron. J. 62:464-467.
4. Brown, K. W. and R. L. Duble. 1975. Physical characteristics of soil mixtures for golf green construction. Agron. J. 67:647-652.
5. Carrow, R. N. and B. J. Johnson. 1989. Turfgrass wear as affected by golf car tire design and traffic patterns. J. Amer. Soc. Hort. Sci. 114:240-246.
6. Gibbs, R. J., W. A. Adams, and S. W. Baker. 1989. Factors affecting the surface stability of a sand rootzone. p. 189-191 In: H. Takatoh (ed.). Proc. Sixth Int. Turfgrass Res. Conf., Tokyo, Japan. 31 July-5 August, 1989. Japanese Soc. Turfgrass Sci. and Int. Turfgrass Soc., Tokyo, Japan.
7. Larcher, W. 1980. Physiological plant ecology. Springer-Verlag. Berlin.
8. Morgan, W. C., J. Letey, S. J. Richards, and N. Valoras. 1966. Physical soil amendments, soil compaction, irrigation, and wetting agents in turfgrass management: I. Effects of compactability, water infiltration rates, evapotranspiration, and number of irrigations. Agron. J. 58:525-535.
9. Shearman, R. C. and J. B. Beard. 1975. Turfgrass wear tolerance mechanisms. II. Effects of cell well constituents on turfgrass wear tolerance. Agron. J. 67:211-215.
10. Shearman, R. C., E. J. Kinbacher, and T. P. Riordan. 1980. Turfgrass-paver complex for intensively trafficked areas. Agron. J. 72:372-374.
11. Swartz, W. E. and L. T. Kardos. 1963. Effects of compaction on physical properties of sand-soil-peat mixtures at various moisture contents. Agron. J. 55:7-10.
12. Taylor, S. E. and G. Pingel. 1971. Asphalt and artificial turf. Missouri Bot. Gard. Bull. 69:26-29.
13. Waldron, L. J. and S. Dakessian. 1982. Effect of grass, legume, and tree roots on soil shearing resistance. Soil Sci. Soc. Am. J. 46:894-899.
14. Wood, G. M. 1973. Use of energy-absorbing materials to permit turf growth in heavily trafficked areas. Agron. J. 65:1004-1005.
15. Youngner, V. B. 1961. Accelerated wear tests on turfgrasses. Agron. J. 53:217-218.

Proc. Fla. State Hort. Soc. 103:355-360. 1990.

INFLUENCE OF PLANTING METHOD, FERTILITY PROGRAM, CULTIVAR, AND SOIL TYPE ON ST. AUGUSTINEGRASS

A. E. DUDECK
University of Florida, IFAS
Environmental Horticulture Department
Gainesville, FL 32611

Additional index words. Floralawn, Floratam, Floratine, grass, plug, Raleigh, sprig, stolonize, turf, turfgrass, vegetative establishment.

Abstract. **Sod production of St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze, is gradually moving from organic muck soils in south Florida to mineral sand soils in central and north Florida. Central Florida also has many acres of reclaimed phosphate mined lands which may have potential for St. Augustinegrass sod production. This report summarizes studies of St. Augustinegrass growth on phosphatic clay and sand soils affected by methods of planting, fertility programs, and cultivars.**

Four-inch plugs planted on 1-foot centers on clay and sand was the best out of 16 vegetative planting methods evaluated. Stolonization was equal to plugs on clay but was the poorest planting method to use on sand soil. Apparently high inherent fertility in phosphatic clay soil negates need for supplemental fertilization after St. Augustinegrass establishment. Fertilization with seven different fertilizer carriers at different rates and frequencies affected only turf color but not

Florida Agricultural Experiment Station Journal Series No. N-00304. The author acknowledges with thanks for support in part from the Polk County Board of County Commissioners, Bartow, FL and Nutri-Turf, Inc., Jacksonville, Florida.

ground cover on clay. All fertilizer treatments increased ground cover as well as turf color on sand. Ammonium sulfate (AS) applied monthly at 1 lb. of N or isobutylidene diurea (IBDU) applied bimonthly at 2 lbs. of N per 1000 per square feet produced superior St. Augustinegrass color when grown on sand soil. No major differences between 'Floratam', 'Floralawn', 'Floratine', and 'Raleigh' St. Augustinegrass were found when grown on clay soil, although 'Raleigh' had inferior color.

St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze, is the most popular lawn grass in Florida (3). Because it does not reproduce true-to-type from seed, it must be vegetatively propagated. In 1988, sod of St. Augustinegrass ws produced on 33,900 acres of muck soils located in southcentral Flordia near Lake Okeechobee (2). Because of soil subsidence of organic soils (5), sod production on mineral sand soil has increased to 27,374 acres (2). Reclaimed mined lands in central Florida also have potential for sod production. To date, the phosphate industry in Florida has mined approximately 140,000 acres in Polk county and will mine approximately 50,000 more acres by the turn of the century (1). Lesser amounts of land have been mined in Hamilton, Hardee, Hillsborough, and Manatee counties. Reclamation of mined lands is critical in affected areas of the state. This paper reports results of several studies on use of reclaimed phosphate mined land as a medium for production of St. Augustinegrass sod. Studies on clay soil were compared to grass response on an Arredondo fine sand (loamy, siliceous, hyperthermic, Grossarenic Paleudult).

Materials and Methods

Planting method. Plots involving 16 vegetative methods of propagation were planted on clay soil on 27 May 1987 at the Turf and Ornamental site, IMC location, Bartow, FL (Table 1). A second study on sand soil was planted 21 June 1988 at the IFAS Turfgrass Field Laboratory, Gainesville, FL. 'Floratam' St. Augustinegrass grown at the latter location was used in both studies. While planting methods on sand were initiated within a few hours of sod harvest, a maximum of 19 h was involved in the clay study due to differences in location of sod source and planting site.

Table 1. Vegetative planting methods of 'Floratam' St. Augustinegrass on clay and sand soils.

Treatment	Description
1.	Square plugs 2 x 2 inches planted on 1-foot centers.
2.	Square plugs 2 x 2 inches planted on 2-foot centers.
3.	Square plugs 2 x 2 inches planted on 3-foot centers.
4.	Square plugs 4 x 4 inches planted on 1-foot centers.
5.	Square plugs 4 x 4 inches planted on 2-foot centers.
6.	Square plugs 4 x 4 inches planted on 3-foot centers.
7.	Furrows one foot apart with single horizontal sprigs at 1-foot centers.
8.	Furrows two feet apart with single horizontal sprigs at 2-foot centers.
9.	Furrows three feet apart with single horizontal sprigs at 3-foot centers.
10.	Furrows one foot apart with horizontal sprigs end to end.
11.	Furrows two feet apart with horizontal sprigs end to end.
12.	Furrows three feet apart with horizontal sprigs end to end.
13.	Single vertical sprigs at 1-foot spacing.
14.	Single vertical sprigs at 2-foot spacing.
15.	Single vertical sprigs at 3-foot spacing.
16.	Stolonize—broadcast sprigs from 1-square foot sod on whole plot, cut in with dull shovel, and topdressed with 0.25 inches of soil by hand.

Two-inch square plugs freshly cut with a mechanical band saw were planted in round holes 2.5 inches in diameter and 3 inches deep. Sprigs were planted by making furrows approximately 1-inch deep with a 1-row push plow. Vertical sprigs were planted in holes 0.5 inches in diameter and 2 inches deep made by hand with a wooden dowel. Sprigs were placed so that one node was deeper than the second node which was located at the surface of the soil. A sprig was defined as having at least two nodes. Stolonized plots were hand planted with a dull, flat shovel prior to topdressing. Topdressing was raked from an adjacent area and hand spread 0.25 inches thick over the broadcasted stolons. Plots within replications were hand watered immediately after planting. Grass hay mulch was hand appliled at the rate of 100 lbs. per 1000 square feet. Water was applied throughout the growing season as needed with overhead sprinkler irrigation.

Immediately before planting, the clay area was lighty tilled with a spike-tooth harrow and then sprayed with glyphosate at the rate of 4 lbs. a.i. per acre to control grass weeds. Imazaquin (Image™) was applied at the rate of 0.375 lbs. of a.i. per acre for purple nutsedge, *Cyperus rotundus* L., control on 24 July and 10 Sept. 1987. Bentazon (Basagram™) was applied to clay at the rate of 1 lb. a.i. per acre for yellow nutsedge, *C. esculentus* L., control on 22 Sept. 1987. Atrazine and imazaquin were applied as a tank mix to the sand study on 15 July 1988.

An 18-4-6 fertilizer was applied to the clay study at the rate of 2.8 lbs. per 1000 square feet on 18 June. It was reapplied at a double rate on 18 July. A 20-0-20 fertilizer at the rate of 5 lbs. per 1000 square feet was applied on 3 Sept. 1987. The sand study was fertilized with a 16-4-8 at 3.1 lbs. per 1000 square feet on 28 June, 13 July, 2 Aug., 17 Aug., and 20 Oct. On 2 Sept., however, a double rate was applied. Fertilizer was watered in with overhead irrigation immediately after application.

Mowing at a 3-inch height of cut with a rotary mower was scheduled on a weekly basis. Occasional periods of rain and wet soil extended the mowing frequency on the clay study. Clippings were not removed from plots.

A randomized complete block with four replications was the statistical design. Individual plots were 6 by 9 feet. Data on percent St. Augustinegrass and weed cover were visually estimated periodically throughout the growing season. All data were subject to analysis of variance (7). Percentages were first transformed for statistical analyses and then retransformed back to percentages for tabular presentation (4). Cover rate which is the sum of monthly average cover estimates for St. Augustinegrass was calculated after Maguire (6).

Fertilizer studies. Several fertilizer treatments involving different materials, frequency, and rate of application were studied on clay and sand soils. Duplicate experiments were initiated at the Turf and Ornamental site, IMC location, Bartow, FL on 7 June 1988 and at the Turfgrass Field Laboratory, Gainesville, FL on 14 June 1988. 'Floratam' St. Augustinegrass at Bartow averaged 65% cover, whereas 'Floralawn' St. Augustinegrass at Gainesville averaged 80% cover when fertilizer treatments were applied.

Eight fertilizer treatments were hand applied to plots 10 by 10 feet in size that were replicated four times in a randomized complete block design (Table 2). Plots were mowed weekly at three inches with a rotary mower, and clippings were not removed from plots. Plots at Bartow, however, could not be mowed on schedule during several wet periods during July and August. Up to two weeks passed between mowings due to inaccessibility to plots. In such cases, clippings of excess growth were removed from plots. Overhead irrigation was applied at both locations to water-in fertilizer after application and to supplement need for watering on an as needed basis. Grass weeds and sedges were treated as needed at Bartow as previously described.

Visual data were gathered at least monthly on percent St. Augustinegrass cover. Color was visually rated at least monthly on a 1 to 9 scale where 1 = poor color and 9 = best, dark green color. All data were subject to analysis of variance (7). Percentage data were first transformed using either square root or angular transformations, as appropriate (4). Transformed data were then retransformed for tabular presentation.

Cultivar evaluation. Four cultivars of St. Augustinegrass were established on the Turf and Ornamental site, IMC location, at Bartow, FL on 29 July 1987. Commercially available cultivars were 'Floralawn', 'Floratam', 'Floratine,' and 'Raleigh'.

Plugs, 4 inches in diameter by 2.5 inches long, were planted 2 feet apart in holes 3 inches deep. 'Floralawn', 'Floratam', and 'Floratine' plugs were obtained from the Turfgrass Field Laboratory, Gainesville, FL, whereas 'Raleigh' plugs were obtained from Nutri-Turf, Inc., Jacksonville, FL. Hence, 'Raleigh' plugs had a different soil compared to other cultivars. Furthermore, 'Raleigh' was constantly irrigated with a brewery effluent during establishment. Plugs were placed in closed plastic bags for transportation to the Bartow site. They were trimmed to 2.5 inches in length immediately before planting. Plugs and planting holes were made with the same size cutter. Individual plots were 6 by 9 feet in size and each contained 12 plugs on 2-foot centers. Statistical design was a randomized complete block with four replications.

Plugs within replications were watered after planting with a hose and nozzle until all air escaped from the plug. All plugs were again lightly watered to runoff after all planting was completed. Water was applied throughout the growing season, as needed, with overhead sprinkler irrigation.

Table 2. Fertilizer frequency, materials, and rates of application on St. Augustinegrass at Bartow and Gainesville, FL during the 1988 growing season. Season total for all treatments was 4 lbs. N per 1000 square feet.

Fertilizer	Rate	Frequency[z]
	lbs N	
16-4-8	1	M
15-0-15	1	M
Ammonium sulfate (AS)	1	M
Isobutylidene diurea (IBDU)	2	B
Urea formaldehyde (UF)	2	B
Sulfur-coated urea (SCU)	2	B
Sewage sludge (SS)	2	B
Control—no fertilizer	–	–

[z]M = monthly, B = bimonthly

Asulam (Asulox™) was applied on 7 Aug. 1987 for postemergence grass weed control. Imazaquin application for Purple nutsedge control was applied 10 Sept. 1987. Bentazon was applied 6 Oct. 1987 for yellow nutsedge control. All herbicides were applied at rates previously described. Asulam and imazaquin were applied only once during the second growing season on 22 June 1988.

During the first growing season, plots were fertilized only once on 2 Sept. 1987. A 20-0-20 was applied at the rate of 5 lbs. per 1000 square feet. During the 1988 growing season, a 16-4-8 fertilizer was applied on 10 May and 12 Sept. at the rate of 6.25 lbs. per 1000 square feet.

Plots were mowed weekly at 3 inches with a rotary mower. Occasional periods of rain and wet soil extended mowing frequency. Clippings were not removed from plots.

Data were gathered on foliage color and ground cover components of St. Augustinegrass and weeds. Color was visually rated on a 1 to 9 scale where 1 = yellow green and 9 = dark green. St. Augustinegrass cover was initially evaluated using a grid with 1-inch squares. The grid was placed over three random plugs per plot. The number of 1-inch squares with green St. Augustinegrass per square foot was converted to percent St. Augustinegrass per plot. St. Augustinegrass cover during the second growing season was based on a single, visual estimate of the entire 6 by 9 foot plot. Percentages were transformed prior to statistical analysis (7) and then retransformed back to percentages for tabular presentation (4).

Results and Discussion

Planting method. Planting method on clay had a significant effect on St. Augustinegrass and grass weed cover throughout the growing season (Table 3). The best planting method which averaged 70% St. Augustinegrass cover

Table 3. Grass weeds and St. Augustinegrass (SA) during the growing season as influenced by method of planting on 27 May 1987 on a clay soil.

Planting Method[z]	Aug.		Sept.		Nov.		Cover Rate[y]
	SA	Weed	SA	Weed	SA	Weed	
	%						
4	70 a[x]	20 f	81 a	8 f	96 a	1 f	59 a
1	45 b	40 e	46 b	35 a	82 ab	5 ef	40 b
16	34 bc	55 c-e	38 bc	46 dc	69 bc	14 de	32 bc
5	32 b-d	50 de	34 b-d	49 de	64 bc	14 de	30 cd
13	17 d-f	67 a-d	26 c-e	54 c-e	60 b-d	16 de	23 c-e
6	25 c-e	58 b-e	24 d-f	58 b-d	46 c-f	28 c-f	22 d-f
2	21 c-f	65 a-d	18 e-h	66 a-d	46 c-f	23 cd	20 e-g
10	13 de	76 ab	17 e-h	72 a-c	55 c-e	28 b-d	18 e-g
7	17 d-f	69 a-d	21 d-g	64 a-d	37 d-g	41 a-c	18 e-g
14	15 ef	66 a-d	15 e-h	62 a-d	29 f-h	49 ab	14 e-h
11	10 f-h	67 a-d	12 f-i	59 a-d	33 e-h	30 b-d	13 f-i
3	10 f-h	75 ab	11 g-i	64 a-d	27 f-h	29 b-d	11 g-i
12	15 ef	62 b-d	9 hi	70 a-c	14 hi	64 a	11 g-i
8	11 fg	73 a-c	10 g-i	64 a-d	19 g-i	43 a-c	10 g-i
15	2 h	81 a	6 i	74 ab	16 g-i	49 ab	6 hi
9	3 gh	76 ab	5 i	77 a	6 i	62 a	4 i

[z]Refer to Table 1 for description of planting methods.
[y]Cover rate = sum of monthly average cover estimates.
[x]Retransformed means within columns with the same letter are not significantly different at the 5% level of probability using Waller Duncan k-ratio *t*-test.

Table 4. St. Augstinegrass ground cover during the growing season as influenced by method of planting on 21 June 1988 on a fine sand soil at Gainesville, FL.

Planting Method[z]	Sept.	Oct.	Nov.	Cover Rate[y]
	---------- % ----------			
4	75 a[x]	83 a	91 a	55 a
10	52 b	76 ab	87 ab	48 b
1	40 c	65 bc	86 ab	38 c
5	36 d	58 cd	82 b-f	34 d
13	30 e	42 e	83 a-e	29 e
11	22 f	53 d	85 a-d	28 e
12	15 g	41 e	84 a-d	23 f
7	14 g	27 f	74 b-h	19 g
6	12 gh	22 f-h	73 d-h	17 g
2	10 hi	24 fg	78 b-g	17 g
8	6 jk	22 f-h	75 b-h	15 gh
14	7 ij	21 f-h	74 c-h	15 gh
9	4 kl	16 gh	70 e-h	12 hi
3	5 j-l	14 h	67 f-h	12 hi
15	3 kl	15 gh	64 gh	11 hi
16	2 l	13 h	62 h	10 i

[z]Refer to Table 1 for description of planting methods.
[y]Cover rate = sum of monthly average cover estimates.
[x]Retransformed means within columns with the same letter are not significantly different at the 5% level of probability using Waller Duncan k-ratio *t*-test.

three months after planting was 4-inch plugs spaced on 1-foot centers. This treatment concurrently had the least weed cover which averaged only 20%. Second best planting methods were 4-inch plugs spaced on 2-foot centers, 2-inch plugs spaced on 1-foot centers, and stolonized sprigs. These treatments averaged 37% St. Augustinegrass cover with 47% weed cover. Other planting methods were ineffective, averaging less than 25% St. Augustinegrass with up to 80% weed cover. These trends continued throughout the growing season. In Nov., best planting methods were 2-inch and 4-inch plugs planted on 1-foot centers. These treatments averaged 89% St. Augustinegrass cover with only 3% weed cover which was six months after planting. Second best planting methods were stolonized sprigs, 4-inch plugs on 2-foot centers, and single vertical sprigs on 1-foot centers. These treatments averaged 64% St. Augustinegrass with 15% weed cover. Single, vertical sprigs developed remarkably well between the fourth and sixth months. St. Augustinegrass cover increased from 26% to 60%. Accordingly, weed cover in this treatment decreased from 54% to 16%, respectively.

Four-inch plugs planted on 1-foot centers had the best ground cover rate of 59% at the close of the growing season (Table 3). Second best cover rate of 36% was produced by stolonized sprigs and 2-inch plugs on 1-foot centers.

There was a strong negative correlation between St. Augustinegrass cover and weed cover. Correlation coefficients between grass and weed cover for Aug., Sept., and Nov. evaluation dates were –0.977, –0.979, and –0.935, respectively. This means that if enough St. Augustinegrass plant material was initially used, planted properly, and managed properly thereafter, resulting ground cover would be predominately desirable grass cover instead of weeds.

Planting method on sand also had a significant effect on St. Augustinegrass cover (Table 4). Best planting method which averaged 75% St. Augustinegrass cover in Sept. after three months of growth was 4-inch plugs planted on 1-foot centers. Furrow planting of sprigs end to end regardless of furrow spacing increased markedly over the next two months to equal St. Augustinegrass cover produced by 2-inch and 4-inch plugs on 1-foot centers and single vertical sprigs on 1-foot centers. This group averaged 86% St. Augustinegrass in Nov. after five months of growth. Four-inch plugs planted on 1-foot centers, however, had the best ground cover rate of 55% St. Augustinegrass compared to all other treatments (Table 4).

There was a significant correlation ($r = 0.685$, $p = 0.003$) between planting methods on clay and sand soil. In general, most planting methods were equally effective, or ineffective, on both soils with the exception of the stolonized planting method (Table 5). Plug planting and stolonizing were equally effective on clay, but stolonizing was the poorest planting method on sand (Tables 4 and 5). Stolonizing is a widely accepted, practical method of vegetatively propagating bermudagrass, *Cynodon* spp. L. Evidently, the thick, coarse St. Augustinegrass stolons were

Table 5. Orthogonal contrasts of planting method on cover rate[z] of St. Augustinegrass on clay and sand soil.

Contrast	Soil type		Contrast	Soil type	
	Clay	Sand		Clay	Sand
	---------- % ----------			---------- % ----------	
Plug vs stolonize	31 ns[y]	36 **	End to end vs spaced sprigs	14 ns	40 ***
	32	16		11	22
Plug vs sprig	30 ***	36 ***	One-foot vs two-foot spacing	35 ***	43 ***
	13	29		19	27
Four-inch vs two-inch plug	37 ***	43 ***	Two-foot vs three-foot spacing	19 **	27 **
	24	29		11	20
Stolonize vs sprig	32 ***	16 ***	Plugs at one-foot vs two-foot spacing	50 ***	55 ***
	13	29		25	32
Stolonize vs vertical sprigs	32 ***	16 ***	Plugs at two-foot vs three-foot spacing	25 *	32 ***
	14	25		17	20
Stolonize vs horiz. sprig centered in furrows	32 ***	16 **	Furrows at one-foot vs two-foot spacing	18 ns	39 ***
	11	22		12	29
Stolonize vs horiz. sprig end to end	32 ***	16 ***	Furrows at two-foot vs three-foot spacing	12 ns	29 *
	14	40		7	25
Vertical vs horiz. sprig	14 ns	25 *			
	11	22			

[z]Cover rate = sum of monthly average cover estimates.
[y]*, **, and *** are significant at p = 0.05, 0.01, and 0.001, respectively.

Table 6. Effects of fertilizer treatments on 'Floratam' St. Augustinegrass ground cover production on clay soil at Bartow, FL.

Fertilizer[z]	22 June	6 July	3 Aug.	21 Sept.	2 Nov.	Season Average
SS	76 a[y]	82 a	90 ab	95 a	98 ab	88 a
15-0-15	79 a	83 a	92 a	90 ab	94 c	87 a
Control	80 a	86 a	90 ab	87 b	90 d	86 a
UF	73 a	78 a	88 ab	94 a	99 a	86 a
SCU	74 a	81 a	88 ab	92 ab	98 ab	86 a
IBDU	72 a	76 a	82 bc	93 ab	96 bc	84 a
16-4-8	75 a	76 a	83 bc	89 ab	97 av	84 a
AS	64 a	70 a	78 c	92 ab	97 ab	80 a

[z]Refer to Table 2 for description of fertilizer treatments.
[y]Retransformed means with the same letter within columns are not significantly different at the 5% level of probability using Waller Duncan k-ratio *t*-test.

not cut in deeply enough and/or watered properly on sand. Also, since sand is more prone to drought than clay, light, frequent watering on sand soil is much more critical than that on clay soil.

Plug planting was more effective on both soils than sprig planting (Table 5). Use of 4-inch plugs was more effective than 2-inch plugs. One-foot spacings of plugs or sprigs within furrows were better than 2-foot spacings. Similarly, 2-foot spacings were more effective than 3-foot spacings. In general, these results indicate that high vegetative planting densities produced best results in the shortest period of time.

Fertilizer studies. Fertilizers on clay soil had little effect on ground cover during the first two months after application as well as on seasonal ground cover average (Table 6). Excellent growth on control plots which received no supplemental fertilization questions need for supplemental fertilization for production of St. Augustinegrass sod on reclaimed phosphate mined lands. However, fertilization had a major influence on color of St. Augustinegrass foliage (Table 7). Most fertilizer treatments with the exception of 15-0-15 produced an equal seasonal color average of 6.4 in 'Floratam' St. Augustinegrass. The 15-0-15 fertilizer plot had an average score of 4.8 and was not different in seasonal color average than the unfertilized control plot which averaged 5.0. Soils high in phosphate are known to compete with micronutrients such as Fe for available exchange sites. Improved turf color with supplemental Fe applications instead of N may be needed periodically on St. Augustinegrass produced on these soils.

Table 7. Effects of fertilizer treatments on 'Floratam' St. Augustinegrass color when grown on clay soil at Bartow, FL.

Fertilizer[z]	22 June	6 July	3 Aug.	21 Sept.	2 Nov.	Season Average
	Rating[y]					
IBDU	6.5 ab[x]	5.3 ab	6.8 ab	8.0 a	6.5 ab	6.6 a
SCU	7.0 a	6.3 a	6.2 a	7.0 bc	6.3 b	6.6 a
16-4-8	6.5 ab	5.3 ab	6.8 a	7.0 bc	7.3 a	6.6 a
AS	6.5 ab	5.8 ab	6.8 a	6.5 c	6.5 ab	6.4 a
UF	6.3 ab	5.0 bc	6.2 a	7.5 ab	6.8 ab	6.4 a
SS	5.5 bc	5.5 ab	6.2 a	7.0 bc	6.3 b	6.1 a
Control	5.0 c	5.0 bc	5.0 b	5.0 d	5.0 c	5.0 b
15-0-15	5.0 c	4.0 c	5.2 b	5.0 d	5.0 c	4.8 b

[z]Refer to Table 2 for description of fertilizer treatments.
[y]Color rated 1 to 9 where 9 = best.
[x]Retransformed means with the same letter within columns are not significantly different at the 5% level of probability using Waller Duncan k-ratio *t*-test.

All fertilizer treatments had a major effect on ground cover production and turf color when 'Floralawn' St. Augustinegrass was grown on a fine sand soil in Gainesville (Tables 8 and 9). Since complete coverage in all plots was noted at the end of Sept., seasonal ground cover average was calculated based on data from June through Sept. These data clearly show the need for supplemental fertilization of St. Augustinegrass when grown on sand soils.

Plots which received ammonium sulfate at 1 lb. of N per 1000 square feet per month and plots which received IBDU at 2 lbs. of N per 1000 square feet bimonthly had a

Table 8. Effects of fertilizer treatments on 'Floralawn' St. Augustinegrass ground cover production on fine sand soil at Gainesville, FL.

Fertilizer[z]	29 June	19 July	16 Aug.	15 Sept.	5 Oct.	1 Nov.	Seasonal Average
16-4-8	96 a[y]	98 a	100 a	100 a	98 a	97 a	98 a
UF	95 ab	96 ab	99 a	99 a	99 a	98 a	97 ab
SS	93 ab	96 ab	100 a	100 a	98 a	98 a	97 ab
SCU	91 ab	95 ab	99 a	100 a	99 a	98 a	96 ab
15-0-15	92 ab	94 ab	99 a	99 a	97 a	93 a	96 ab
IBDU	91 ab	93 b	99 a	100 a	98 a	97 a	96 ab
AS	90 bc	93 b	98 a	99 a	99 a	98 a	95 b
Control	85 c	88 c	95 b	96 b	95 a	93 a	91 c

[z]Refer to Table 2 for discussion of fertilizer treatments.
[y]Retransformed means with the same letter within columns are not significantly different at the 5% level of probability using Waller-Duncan k-ratio *t*-test.

Table 9. Effects of fertilizer treatments on 'Floralawn' St. Augustinegrass color when grown on fine sand at Gainesville, FL.

Fertilizer[z]	9 June	19 July	16 Aug.	15 Sept.	5 Oct.	1 Nov.	Season Average
	Rating[y]						
AS	7.0 a[x]	7.1 a	7.5 a	7.4 ab	8.0 a	7.0 a	7.3 a
IBDU	6.8 ab	6.9 ab	7.4 a	7.8 a	7.8 ab	7.0 a	7.2 a
SS	7.0 a	6.4 c	7.1 ab	6.9 bc	7.0 bc	6.2 ab	6.8 b
SCU	7.2 a	6.5 bc	7.4 a	6.9 bc	6.8 c	5.8 bc	6.8 b
16-4-8	6.0 b	6.4 c	7.2 ab	6.8 c	7.2 a-c	6.5 ab	6.7 b
UF	6.5 ab	6.1 c	6.5 b	6.0 d	6.5 c	6.2 ab	6.3 b
15-0-15	5.0 c	5.2 d	4.9 c	4.8 e	5.2 d	4.8 cd	5.0 c
Control	5.0 c	5.0 d	4.8 c	3.9 f	3.8 e	4.2 d	4.4 d

[z]Refer to Table 2 for description of fertilizer treatments.
[y]Color rated 1 to 9 where 9 = best.
[x]Means within columns with the same letter are not significantly different at the 5% level of probability using Waller Duncan k-ratio *t*-test.

Table 10. Performance of St. Augustinegrass cultivars during the first growing season on clay soil in 1987 at Bartow, FL.

Cultivar	25 Aug. Color[z]	10 Sept. Color	22 Sept. Color	7 Oct. Color	7 Oct. Cover	24 Nov. Color	24 Nov. Cover
	Rating	Rating	Rating	Rating	%	Rating	%
Raleigh	8.2a[y]	7.2 a	8.0 a	6.8 a	10 a	6.8 a	30 a
Floratine	5.0 b	5.5 b	6.5 b	6.5 a	8 b	6.2 a	29 a
Floratam	3.5 bc	5.0 b	4.5 c	4.8 a	5 c	6.2 a	25 a
Floralawn	3.2 c	4.5 b	4.8 c	4.2 b	5 c	5.8 a	26 a

[z]Color rated 1 to 9 where 1 = yellow green, while 9 = dark green color.
[y]Means within columns with the same letters are not significantly different at the 5% level of probability using Waller-Duncan k-ratio *t*-test.

Table 11. Color ratings of St. Augustinegrass cultivars during the second growing season on clay soil in 1988 at Bartow, FL.

Cultivar	29 Mar.	21 Apr.	7 June	22 June	3 Aug.	21 Sept.	2 Nov.	Seasonal Average
	Rating[z]							
Floratine	6.0 a[y]	6.0 a	6.5 a	6.2 a	7.0 a	7.8 a	6.8 a	6.6 a
Floralawn	6.0 a	6.2 a	6.0 a	5.5 a	6.0 a	7.0 a	6.8 a	6.2 ab
Floratam	5.8 a	6.0 a	5.8 a	5.5 a	5.8 a	6.8 a	6.2 a	6.0 ab
Raleigh	5.0 b	4.8 b	6.2 a	5.2 a	6.8 a	5.2 b	5.5 a	5.5 b

[z]Color rated 1 to 9 where 1 = yellow green while 9 = dark green color.
[y]Means within columns with the same letter are not significantly different at the 5% level of probability using Waller Duncan k-ratio *t*-test.

seasonal color score average of 7.2 which was better than all other treatments. The 15-0-15 fertilizer treatment once again produced poor color scores throughout the growing season which were no better than that of the unfertilized control plot (Table 9). Unfortunately, label information on sources of N and K carriers in the 15-0-15 was not available.

Color ratings of St. Augustinegrass response to fertilizer treatments on clay and sand soils were correlated ($r = 0.917$, $p = 0.001$). Ground cover production on both soils, however, was not correlated ($r = -0.005$, $p = 0.99$). Inherent fertility associated with the phosphatic clay soil at Bartow apparently negates need for supplemental fertilization after a St. Augustinegrass sod is first established.

Cultivar evaluation. Cultivars differed in color and cover during the first three months of establishment (Table 10). 'Raleigh' had best color up to ten weeks after planting at which time ground cover per plot averaged 10%. At the same time 'Floratine' averaged 8% ground cover and had a color score comparable to 'Raleigh'. 'Floralawn' and 'Floratam' averaged 5% ground cover with inferior color scores of 4.5. No differences in color or ground cover were found between cultivars, however, at the close of the first growing season in Nov. of 1987. St. Augustinegrass cover averaged 28% over all cultivars.

Superior color and cover of 'Raleigh' during the first three months of growth was due to source of plugs. Brewery effluent with which 'Raleigh' was irrigated contained organic N which builds up in soil due to heavy waste water loading rates. Slow release of N caused early superiority of 'Raleigh' which dissipated after four months in the field.

The relatively mild winter of 1987-88 enhanced continued growth of all cultivars as ground cover averaged 81% and was not different between cultivars when evaluated in Mar. of 1988. No cultivar differences in ground cover were found at monthly intervals throughout the 1988 growing season.

Table 12. Color ratings of St. Augustinegrass cultivars during the third growing season on clay soil in 1989 at Bartow, FL.

	15 Apr.	15 July	15 Aug.	Seasonal Average
	Rating[z]			
Floratine	6.0 a[y]	6.5 a	6.2 a	6.2 a
Floralawn	6.0 a	6.0 a	5.5 ab	5.8 a
Floratam	6.0 a	6.2 a	5.2 b	5.8 a
Raleigh	5.2 b	5.0 b	4.2 c	4.8 b

[z]Color rated 1 to 9 where 1 = yellow green while 9 = dark green color.
[y]Means within columns with the same letter are not significantly different at the 5% level of probability using Waller Duncan k-ratio *t*-test.

'Raleigh' St. Augustinegrass had inferior color in Mar., Apr., and Sept. of the second growing season (Table 11) as well as throughout the third growing season (Table 12). These data confirm other field reports that 'Raleigh' has occasionally become yellow-green in color after establishment which is aesthetically undesirable. Supplemental applications of Fe should be used instead of N during these periods for a more desirable dark green color.

Literature Cited

1. Anonymous. 1989. Mined lands agricultural research/demonstration project. Polk County IFAS Ext. Serv., Environ. Serv. Div., and Polk County Board of County Comm. pp. 72.
2. Cisar, J. L., J. J. Haydu, S. D. Verkade, and K. E. Williams. 1988. The 1987 Florida sod production survey. Proc. Fla. State Hort. Soc. 101:129-131.
3. Florida Department of Agriculture and Consumer Services. 1976. Florida Turfgrass Survey, 1974. Crop and Livestock Rpt. Serv., Fla. Dept. Agr. Consumer Serv., Tallahassee, FL.
4. Little, T. M. and F. J. Hills. 1978. Agricultural experimentation—design and analysis. John Wiley and Sons. New York, NY.
5. Lucas, R. E. 1982. Organic soils (histosols): formation, distribution, physical and chemical properties, and management for crop production. Research Rpt. 435. Farm Sci.
6. Maguire, J. D. 1962. Speed of gremination-aid in selection and evaluation for seedling emergence and vigor. Crop Sci. 2:176-177.
7. SAS. 1985. SAS users guide, 5th ed. SAS Institute Inc., Cary, NC.